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HARDNESS OF PORK FAT AS AFFECTED BY ALFALFA PASTURE AND BY BREED

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CALIFORNIA BUTCHERS AND PACKERS in general believe that the growing and fattening of pigs on large quantities of green alfalfa pasture or skim milk and green alfalfa result in the production of undesirable carcasses. Feeding acorns, peanuts, soybeans, and the like to hogs is known to produce soft pork. Such carcasses do not become firm even when hung in the coolers for 48 hours at temperatures a few degrees above freezing. The fat contains an excessive amount of unsaturated fatty acids deposited there from the fats in the feeds consumed. Barley, alfalfa, tankage, and skim milk, commonly fed to pigs in this state are relatively low in fat content and therefore contain only small quantities of the unsaturated fatty acids. Our knowledge of the causes of soft-pork carcasses seemed not to justify the belief that the consumption of large amounts of green alfalfa pasture would result in soft, undesirable pork. Since, however, the opinion was so prevalent, a coöperative experiment was begun in 1924 to study this problem. As an outgrowth of the feeding study, breed differences became apparent and this phase is discussed in the latter part of the bulletin.

FEEDING TRIALS

Procedure.—All the pigs used in these feeding trials were fed at the California Agricultural Experiment Station and were purebreds from Duroc-Jersey and Poland China sows. The sows received normal rations and had free access to alfalfa pasture throughout gestation and lactation. The experimental pigs were placed on feed soon after weaning, and the experiment concluded when they weighed about 200 pounds. They were slaughtered in a modern killing plant; and the carcasses, after 48 hours in the cooler, were graded for firmness by a committee of three. Back-fat samples were cut from a position over the fifth to eighth ribs and were taken immediately to the laboratory. When the skin had been

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[2] Acknowledgment is made of coöperation by the Bureau of Animal Industry, United States Department of Agriculture, which in the early phases of the experiment made the refractive-index determinations and assisted in the grading of the chilled carcasses.

[3] Professor of Animal Husbandry and Animal Husbandman in the Experiment Station.

removed from the samples, the fat was cut into small cubes and rendered in an electric oven at a temperature of 100° to 120° centigrade. The rendered fat was filtered into 2-ounce bottles, cooled, sealed, and sent to the United States Experimental Farm, Beltsville, Maryland, for determination of the refractive index, a reliable measure of the hardness of the fat. The pigs used were uniform in size, age, type, quality, and thriftiness (fig. 1). When two or more lots were used, the pigs in them were divided

Fig. 1.—Duroc-Jersey and Poland China pigs used in these experiments. Photograph taken at the close of one of the trials.

as uniformly as possible. In the first trial rolled barley and tankage were self-fed in separate feeders with the pigs on alfalfa pasture. In the other tests the alfalfa pasture was supplemented with a limited ration of rolled barley and skim milk which were hand-fed. The grain ration was limited in an effort to force the pigs to consume a large amount of pasture. They were fed enough to produce an average daily gain of about 1 pound.

Gains Made in the Feeding Trials.—The feeding data pertaining to the various trials are presented in tables 1 and 2.

Except for the 42 head (table 1) fed barley and tankage, the pigs were given only a limited amount of concentrates. This fact was reflected in the average daily gains. The pigs did consume quantities of alfalfa pasture, for they kept the alfalfa short even though it was watered regularly and often.

A comparison of the amount of barley and skim milk consumed for 100 pounds of gain is interesting because less feed was required for a unit of gain by the pigs fed barley and skim milk in dry lot than on pasture. Similar results had been reported by Foster and Merrill[(2)][4] in 1900.

[4] Superscript numbers in parentheses refer to "Literature Cited," at the end of the bulletin.

Effect of the Feeds on Firmness of Carcass.—Two measures of firmness or hardness of the carcasses were employed: (1) physical grading of the carcasses by a committee, after at least 48 hours storage in the cooler; and (2) the refractive index of the rendered back or leaf fat.

TABLE 1

RESULTS OF FEEDING TRIALS WITH PIGS ON ALFALFA PASTURE

Trial No.	Number of pigs	Average initial weight, pounds	Average final weight, pounds	Average daily gain, pounds	Pounds of feed consumed for 100 pounds of gain (pasture not included)
1	42	51.41	190.21	1.24	Rolled barley..... 399.09 Tankage..... 11.70
2	31	50.12	203.42	0.92	Rolled barley..... 275.00 Skim milk..... 822.71
3*	29	49.22	205.38	1.00	Rolled barley..... 285.29 Skim milk..... 853.30
4	30	51.00	194.67	0.93	Rolled barley..... 282.48 Skim milk..... 847.45
5	38	43.03	179.16	0.97	Rolled barley..... 278.77 Skim milk..... 836.31
Weighted average..		48.86	193.52	1.03	Rolled barley.....280.21† Skim milk..... 839.48

* Conducted in winter; the pasture was not as good as average.

† Average for 128 head fed rolled barley and skim milk. Trial 1 is not included because barley and tankage were fed.

TABLE 2

RESULTS OF FEEDING TRIALS IN DRY LOT*

Trial No.	Number of pigs	Average initial weight, pounds	Average final weight, pounds	Average daily gain, pounds	Pounds of feed consumed for 100 pounds of gain
4	10	51.00	207.40	1.02	Rolled barley..... 403.09 Tankage..... 40.31
5	38	40.23	186.79	1.05	Rolled barley..... 262.44 Skim milk..... 787.32

* These dry-lot trials serve as checks on the trials reported in table 1.

These are the standard measurements used for such studies. The refractive index was originally adopted by workers in this field as a test for the back fat because it could be determined rapidly and has given satisfactory results as a measure of firmness.

The results with respect to firmness of carcass (tables 3 and 4) are significant because they show little or no difference between the carcasses from either group, whether the pigs had access to pasture or not.

All the carcasses in both groups would be considered commercially hard except 7 that graded soft. There were no oily carcasses. Although the average value for the refractive index would indicate that the carcasses were all hard, there was some variation. The highest refractive-index values in each of the pasture-fed groups (averages for which are given in table 3) were 1.4603, 1.4600, 1.4590, 1.4593, and 1.4597 respectively.

TABLE 3

SUMMARY OF THE PHYSICAL GRADING IN THE COOLER AND OF THE REFRACTIVE-INDEX VALUES OF THE FAT FROM THE PIGS FATTENED ON PASTURE

Trial No.	Number of carcasses	Physical grades				Average refractive index of the back fat
		Hard	Medium hard	Medium soft	Soft	
1	29*	..	..	..	..	1.4595
2	31	18	8	4	1	1.4592
3	29	12	6	9	2	1.4585
4	29†	15	8	6	0	1.4585
5	37‡	21	13	3	0	1.4586
Total or weighted average	155	66	35	22	3	1.4588

* Only 29 of the 42 head fed were slaughtered. Thirteen of the pigs were kept in the herd.
† Only 29; one very small carcass had been excluded.
‡ Only 37; one extremely light carcass had been excluded.

TABLE 4

SUMMARY OF THE PHYSICAL GRADING IN THE COOLER AND OF THE REFRACTIVE-INDEX VALUES OF THE FAT FROM THE PIGS FED IN DRY LOT

Ration fed, without pasture	Number of carcasses	Physical grades				Average refractive index of the back fat
		Hard	Medium hard	Medium soft	Soft	
Rolled barley and tankage	10	7	3	0	0	1.4590
Rolled barley and skim milk	36	13	7	12	4	1.4590
Total or weighted average	46	20	10	12	4	1.4590

The highest values for the pigs fed in dry lot (table 4) were, respectively, 1.4597 and 1.4599. Carcasses having a back-fat refractive index of 1.4597 and below are considered hard by Hankins and Ellis.[3]

It is known that body fats are formed from carbohydrates;[1] and it is probably also true that proteins, if consumed in sufficient quantities, may furnish a source of fat. Woodman and co-workers[4] have shown that a high-protein diet did not influence the iodine number of the fillet (internal) fat; it did cause, however, a very slight softening of the back fat though the effect was so small as to be of no practical significance. In this

case the condition may have been due to a decrease in the barley content, and to an increase in the meat meal and soybean meal of the high-protein diet which would result in an increase in the fat content.

All the evidence indicates that carbohydrates and proteins produce a hard body fat. Since the feeds used in the experiments under discussion contained a relatively small percentage of fat and since the proteins

TABLE 5

Summary of the Physical Grading in the Cooler and of the Refractive-Index Values of the Fat from All Poland China and Duroc-Jersey Hogs in the Feeding Trials

Ration fed	Breed	Number of carcasses	Physical grades				Average refractive index of the back fat
			Hard	Medium hard	Medium soft	Soft	
Rolled barley and tankage, with and without pasture	Duroc-Jersey	16*	5	0	0	0	1.4591
	Poland China	23†	2	3	0	0	1.4597
Rolled barley and skim milk with and without pasture	Duroc-Jersey	75	61	12	2	0	1.4585
	Poland China	87	18	30	32	7	1.4590
Total or weighted average	Duroc-Jersey	91‡	66	12	2	0	1.4586
	Poland China	110‡	20	33	32	7	1.4591

* Only 5 of the 16 carcasses were graded.
† Only 5 of the 23 carcasses were graded.
‡ Not all the carcasses were graded.

and carbohydrates would produce hard body fat, the carcasses might logically have been expected to be hard. Individual carcasses varied somewhat in their hardness as measured by the tests used.

DIFFERENCES FOUND IN THE DUROC-JERSEY AND POLAND CHINA CARCASSES

In the process of grading the carcasses and of obtaining the refractive-index values of the fat an interesting observation was accidentally made. In the five feeding trials concluded it was noticed that the Duroc-Jersey carcasses graded harder and the average refractive-index values for the fat were lower than for the Poland Chinas.

Purebred Duroc-Jersey and Poland China barrows and gilts were used in these tests. They were about the same age and weight when the various feeding periods began. They had been raised together, fed the same feeds in the same troughs or self-feeders, and given free access to alfalfa pasture. In fact their mothers had been fed the same feed together in the same pastures throughout gestation and lactation. The pigs were similar in all respects; in type they were neither short and "chubby"

nor tall and rangy. In numbers they were about equally divided between the two breeds.

Table 5 summarizes the physical grading of the carcasses by a committee of three and the average refractive-index values for the back fat by breeds. Of the 80 Duroc-Jersey carcasses graded, 82.5 per cent graded hard; 15.0 per cent, medium hard; and 2.5 per cent, medium soft. Ninety-two Poland China carcasses were graded, with the following results: 21.7 per cent graded hard; 35.9 per cent, medium hard; 34.8 per

TABLE 6

DISTRIBUTION OF THE REFRACTIVE-INDEX VALUES FOR DUROC-JERSEYS AND POLAND CHINAS

Breed	Refractive-index range groups									
	1.4575 1.4577	1.4578 1.4580	1.4581 1.4583	1.4584 1.4586	1.4587 1.4589	1.4590 1.4592	1.4593 1.4595	1.4596 1.4598	1.4599 1.4601	1.4602 1.4604
Duroc-Jersey....	3	12	17	21	16	16	4	2	0	0
Poland China...	0	0	0	13	28	22	23	11	10	3

cent, medium soft; and 7.6 per cent, soft. There was a significant difference in the refractive-index values—an average of 1.4586 for the Duroc-Jersey and 1.4591 for the Poland China carcasses.

Table 6, a distribution table, shows how the refractive-index values varied in the two breeds. The highest value for the Duroc-Jersey carcasses was 1.4598; the lowest, 1.4575. The range for those of the Poland Chinas was 1.4604 to 1.4584. The difference between the highest and the lowest in the two cases is about the same, but the Poland Chinas are distinctly higher. In either case the differences were large enough to be significant.

After the first two feeding trials were completed and the results tabulated, it was decided to purchase some animals bred in other herds and not related to the stock used in the experiments just discussed. Nine purebred Poland China feeder pigs were purchased and fed with the Station pigs in the third trial. The results of grading the purchased pigs at slaughter were numerically as follows: 2 hard, 1 medium hard, 4 medium soft, and 2 soft. Their average refractive-index value was 1.4587, the same as an average of 10 Poland Chinas bred at the Station. The average value for 10 Duroc-Jerseys in the same feeding trial was 1.4582.

Before the fifth trial began, some purebred Duroc-Jersey and Poland China bred sows were purchased from California breeders. They were placed in the same pasture and fed the same feeds as the Station sows during gestation and lactation. In this test, pigs from Station and from

purchased sows were raised and fattened together. The results of grading the carcasses from purchased Duroc-Jersey sows were numerically as follows: 11 hard, 4 medium hard, 2 medium soft; from the Poland China sows there were 5 hard, 7 medium hard, 1 medium soft, and 2 soft. The average refractive-index values were for Duroc-Jerseys 1.4585 and for Poland Chinas 1.4589. In general the same differences were manifested in the pigs purchased as in the pigs from the Station herd.

To check the results further, carcasses from purebred Duroc-Jersey and Poland China barrows exhibited at a recent fat-stock show were graded, and leaf-fat samples obtained. Before slaughtering, the animals varied in weight from 190 to 225 pounds. In the opinion of the grading committee the Poland China carcasses surpassed the Duroc-Jersey in shape and in thickness of the back fat. The carcasses were picked at random and were those of well-fed pigs from various sections of the state. The results of the grading were as follows: Duroc-Jerseys, 15 hard, 9 medium hard; Poland Chinas, 9 hard, 8 medium hard, and 3 medium soft. All were commercially "hard." The average refractive index for the Duroc Jerseys was 1.4571, with a range of 1,4565 to 1.4578; for Poland Chinas 1.4580, with a range of 1.4571 to 1.4589.

Of the total of 245 carcasses examined for hardness only 7 would be classed as commercially soft. That breeds within a species should be physiologically different is not surprising. It is an established fact that the fine-wool breeds of sheep have a longer gestation period than the middle-wooled or down breeds. It is well known, too, that the fat produced by Guernsey and Jersey cattle is more highly colored than that of the Holstein. That Duroc-Jersey and Poland China pigs, in their utilization of food nutrients, differ in the type of fat produced and deposited in the fat depots now seems certain.

SUMMARY

Carcasses from pigs fed barley, tankage, and a limited ration of barley and skim milk on alfalfa pastures were as hard as those from pigs fed the same rations in dry lot. Alfalfa pasture and skim milk did not affect the carcasses in these studies as measured by physical grading in the coolers and by the refractive index of the back fat.

Pigs weighing from 50 to 200 pounds fed a limited ration of rolled barley and skim milk and given free access to alfalfa pasture consumed an average of 280.16 pounds of barley and 840.48 pounds of skim milk for 100 pounds of gain.

By means of the two measurements—physical grading of the carcasses in the cooler at a temperature of about 36° Fahrenheit, 48 hours

after slaughter, and by readings of the refractive index of the fat—it was found that the Duroc-Jersey carcasses and back and leaf fat from finished pigs weighing about 200 pounds before slaughter were firmer than those of similar Poland Chinas under the conditions of the present experiment.

The average refractive index for the back and leaf fat of 115 Duroc-Jersey carcasses examined was 1.4582; for 130 Poland China carcasses, 1.4590.

The results of the grading were numerically as follows: for 104 Duroc-Jersey carcasses, 81 hard, 21 medium hard, 2 medium soft; for the 112 Poland China carcasses, 29 hard, 41 medium hard, 35 medium soft, and 7 soft.

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